

OPTICAL MODULE, WAFER SCALE PACKAGE, AND METHOD FOR MANUFACTURING THOSE

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The invention is in the field of integrated optical modules, in particular integrated camera devices with an image capturing element, such as a CCD or CMOS sensor, and at least one lens element for imaging an object on the image capturing element, e.g. a refractive and/or diffractive lens. Integrated device means that all components are arranged in a well defined spatial relationship. Such integrated camera devices are, for example, cameras of mobile phones which are preferably manufactured in a mass production process at low cost.

[0003] More concretely, the invention relates to an optical module for a camera device comprising an EMC shield. The invention further relates to a wafer scale package representing a plurality of such optical modules, and to a method for manufacturing a plurality of optical modules on a wafer scale.

[0004] 2. Description of Related Art

[0005] Especially in the field of mobile phones with cameras, but also for other applications, it is desirable to have a camera device that can be mass produced at low cost in an as simple process as possible and still has a good image quality. Such camera devices comprise an image capturing element and at least one lens element arranged along a common axis, and are known from WO 2004/027880, for example. The known camera devices are manufactured on a wafer scale by replicating a plurality of lens elements on a disk-like substrate (wafer), stacking and connecting the substrates to form a wafer scale package (wafer stack) and dicing the stack in order to separate the individual camera devices from one another.

[0006] The camera devices are integrated optical modules, which include functional elements such as the image capturing element and the at least one lens stacked together along the general direction of light propagation. These elements are arranged in a predetermined spatial relationship with respect to one another (integrated device) such that further alignment with each other is not needed, leaving only the integrated device as such to be aligned with other systems.

[0007] Wafer-scale replication of lens elements allows the fabrication of several hundreds of generally identical devices with a single step, e.g. a single or double-sided UV-embossing process. Replication techniques include injection molding, roller hot embossing, flat-bed hot embossing, UV embossing. As an example, in the UV embossing process the surface topology of a master structure is replicated into a thin film of a UV-curable replication material such as an UV curable epoxy resin on top of a substrate. The replicated surface topology can be a refractive or a diffractive optically effective structure, or a combination of both. For replicating, a replication tool bearing a plurality of replication sections that are a negative copy of the optical structures to be manufactured is prepared, e.g. from a master. The tool is then used to UV-emboss the epoxy resin. The master can be a lithographically fabricated structure in fused silica or silicon, a laser or e-beam written structure, a diamond turned structure or any other type of structure. The master may also be a submaster produced in a multi stage generation process by replication from a (super) master.

[0008] A substrate or wafer in the meaning used in this text is a disc or a rectangular plate or a plate of any other shape of any dimensionally stable, often transparent material. The diameter of a wafer disk is typically between 5 cm and 40 cm, for example between 10 cm and 31 cm. Often it is cylindrical with a diameter of either 2, 4, 6, 8 or 12 inches, one inch being about 2.54 cm. The wafer thickness is for example between 0.2 mm and 10 mm, typically between 0.4 mm and 6 mm.

[0009] If light needs to travel through the substrate, the substrate is at least partially transparent. Otherwise, the substrate can be nontransparent as well. In case of a camera device, at least one substrate bears electro-optical functional components, like the image capturing element, and may thus be a silicon or GaAs or other semiconductor based wafer; it may also be a CMOS wafer or a wafer carrying CCD arrays or an array of Position Sensitive Detectors.

[0010] Integrated optical modules can be manufactured by stacking wafers along the axis corresponding to the direction of the smallest wafer dimension (axial direction). The wafers comprise lens elements or functional elements, like image capturing elements, in a well defined spatial arrangement on the wafer. By choosing this spatial arrangement in an adequate way, a wafer stack comprising a plurality of generally identical integrated optical modules can be formed, wherein the elements of the optical module have a well defined spatial relationship with respect to one another.

[0011] By spacer means, e.g. a plurality of separated spacers or an interconnected spacer matrix as disclosed in US 2003/0010431 or WO 2004/027880, the wafers can be spaced from one another, and lens elements can also be arranged between the wafers on a wafer surface facing another wafer.

[0012] It is known to place a baffle in front of the top lens element of a camera device. A baffle is an element that defines a three-dimensional passage for light, but is otherwise intransparent for light. In a camera device, a baffle serves to define a field of view (FOV) of the image capturing element and to suppress beam paths coming from points outside this FOV. Known baffles comprise a front wall of non-transparent material having a given thickness in an axial direction and a through-hole for light transmission with normally varying cross sectional areas, and have side walls projecting from the front wall which normally surround the complete device in the manner of a housing. In known baffles, the through-hole has the shape of a truncated cone with a given extent in the axial direction and given opening angle. The thickness as well as the angle of the side walls of the through hole determines the FOV and the critical angle (collection angle) under which incident light can pass the baffle and enter the camera device.

[0013] Electromagnetic compatibility (EMC) refers to the ability of an electrical device to work satisfactorily in its electromagnetic environment without adversely either influencing the surrounding devices, or being influenced by them. Electromagnetic shielding (EMC shielding) limits the flow of electromagnetic fields between two locations, by separating them with a barrier made of conductive material. Typically it is applied to enclosures, separating electrical units from the 'outside world', and to cables, separating wires from the environment the cable runs through. Electromagnetic shielding used to block radio frequency electromagnetic radiation is also known as RF shielding.

[0014] The shielding can reduce the coupling of radio waves, electromagnetic fields and electrostatic fields, though not static or low-frequency magnetic fields. The amount of